# Parameter Estimation of a Flow-Measurement Function Used in Digital Angiography

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The purpose of angiographical procedures [1], [2] used in cardiovascular interventions is to classify the patient's potential of regeneration after strokes caused by dead blood cells in the main arteria. The main question of a surgeon is whether the affected cardiac muscle is able to regenerate by allowing blood to flow in and out, or not. The flow of blood into heart's capillaries is measured using x-ray radiometry with contrastive fluids [3], [4].

The intensity of the contrastive fluid flowing into the target cardiac muscle area is determined by means of image processing on angiogramms produced during the radiometry, thus resulting a dataset of positive intensity values. Our task was to estimate the parameters of a 5-parameter Gamma function — which is well-verified for such problems in this domain — which provides valueable information to the medical team about the patient's status. The parameter-estimation of the former function is hard given that the raw dataset is heavily polluted with several different noise types.

We propose a solution for eliminating the noise by applying a specially designed moving window Gauss filter. We have successfully verified the proposed smoothing algorithm which lets us to use the Levenberg-Marquardt local search method on the smoothed dataset. The parameter estimation is done in a nonlinear least-squares way. Our results showed that higher precision, lower processing times and faster convergence could be achieved using the smoothed dataset rather than the original one.

Moreover, we designed an algorithm for computing an initial guess for the LM algorithm in order to achieve ultimate precision. The method is based on the functional analysis of the Gamma model, and statistical computations on the original dataset. Feeding the LM with the precomputed initial guess, the residuals decreased apace.

Finally, a third algorithm is proposed for selecting significant points on the smoothed dataset with an interval-based classification method. By selecting 10 to 30 significant points from the average of 200 data points showed that the parameters of the Gamma model coudl be approximated more precisely to the correct values in a biological (not numerical) sense.

## Acknowledgements

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**References**

[1] C.M. Gibson, S. Albert *Angiographic Assessment of Both Epicardial and Myocardial Perfusion*, Circulation, **109**, 3096-3105, (2004)

[2] J. Hung-Chi Yu *3D Digital Subtraction Angiography*

[3] C.M. Gibson, M. Anshelevich, S. Murphy *Impact of injections during diagnostic coronary angiography on coronary patency in the setting of acute myocardial infarction from the TIMI trials*, Am J Cardiol., **86**, 1378-1379, (2000)

[4] C.M. Gibson, A.J. Kirtane, S.A Murphy *Impact of contrast agent type (ionic versus non-ionic) used for coronary angiography on angiographic, electrocardiographic and clinical outcomes following thrombolytic administration in acute MI.*, Catheter Cardiovasc Interv, **53**, 6-11, (2001)